# Overview of Perchlorate Treatment Technology Efforts

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# Background

- Perchlorate ($ClO_4^-$) chemistry
  - Highly oxidized but generally unreactive
  - It's a salt, in many ways similar to nitrate ($NO_3^-$)
- What does this mean?
  - Mobile in subsurface but stable: BIG PLUMES!
  - Same for surface water: LARGE AREA AFFECTED
  - Treatability:
    - Not technically difficult, but development & optimization required
    - Potentially very costly due to volume of water requiring treatment

# Uses of Perchlorate

## Ammonium Perchlorate:

**A National Technical Asset Integral to Defense Systems**

- Tactical and Strategic Rocket Motors
- Mines
- Torpedoes
- Munitions

# General Categories

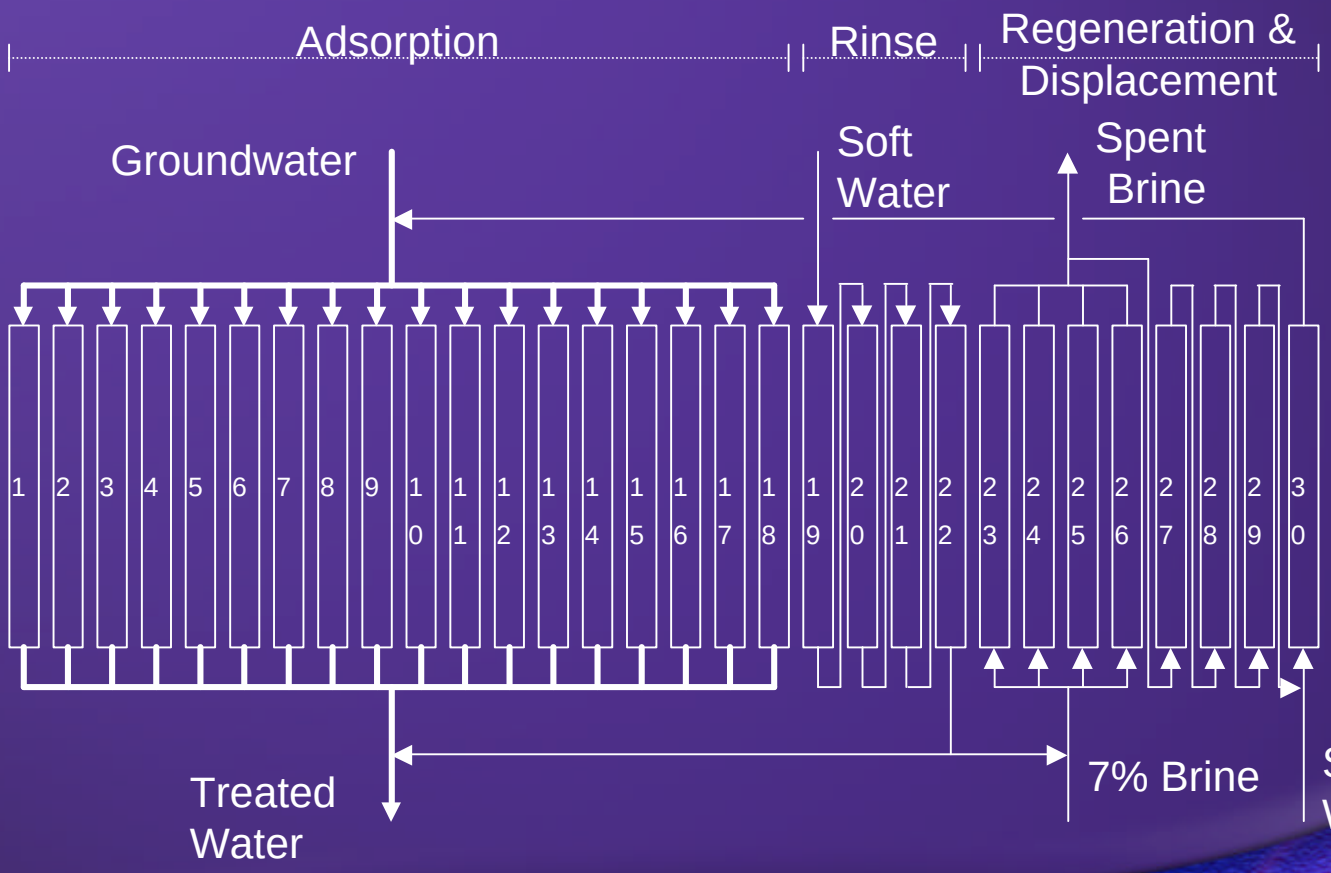
- Physical Processes
  - Ion Exchange
  - Selective Ion Exchange
  - GAC/Modified GAC
  - Reverse Osmosis
- Chemical Processes
  - Catalysis/Reactor
- Biological Processes (Ex Situ - Anaerobic or Anoxic)
  - Bioreactors
  - Packed Bed
  - Fluidized Bed
- In Situ Bioremediation
  - Passive Reactive Barrier
  - Substrate Injection
- Phytoremediation
  - bench/pilot scale

# Perchlorate R&D and Commercial Relationships

- AWWARF
  - Northwestern University
  - Penn State University (CDM/ UNLV/City of Redlands, CA)
  - Clarkson University
  - University of Illinois/Metro Water District of S. Calif.
  - University of Colorado/Nat. Institute of Standards and Technology/ Metro Water District of S. Calif. (LA)
  - University of Houston
- SERDP/ESTCP
  - Southern Illinois University
  - Envirogen
  - Geosyntec
  - Solutions
  - Applied Research Associates
- NSF
  - Penn State University
  - Iowa State University

# Ion Exchange Removal of Perchlorate in Groundwater

## Process Flow Diagram for ISEP® System, Calgon Corp



# Ion Exchange Removal of Perchlorate in Groundwater

Calgon Corp, La Puente, CA

# Selective Ion Exchange Removal of Perchlorate in Groundwater

**Edwards AFB, and ESTCP**

- ORNL
  - Bifunctional Resin with both large and small alkyl groups
  - Now Commercially Available
- Regeneration
  - Patent Pending Tetrachloroferrate in ferric chloride solution
  - Perchlorate Precipitation w/concentrated KOH
- Benefits
  - Highly Selective for Perchlorate
  - Less Effluent Generation
  - No Remineralization
  - Lower O+M costs

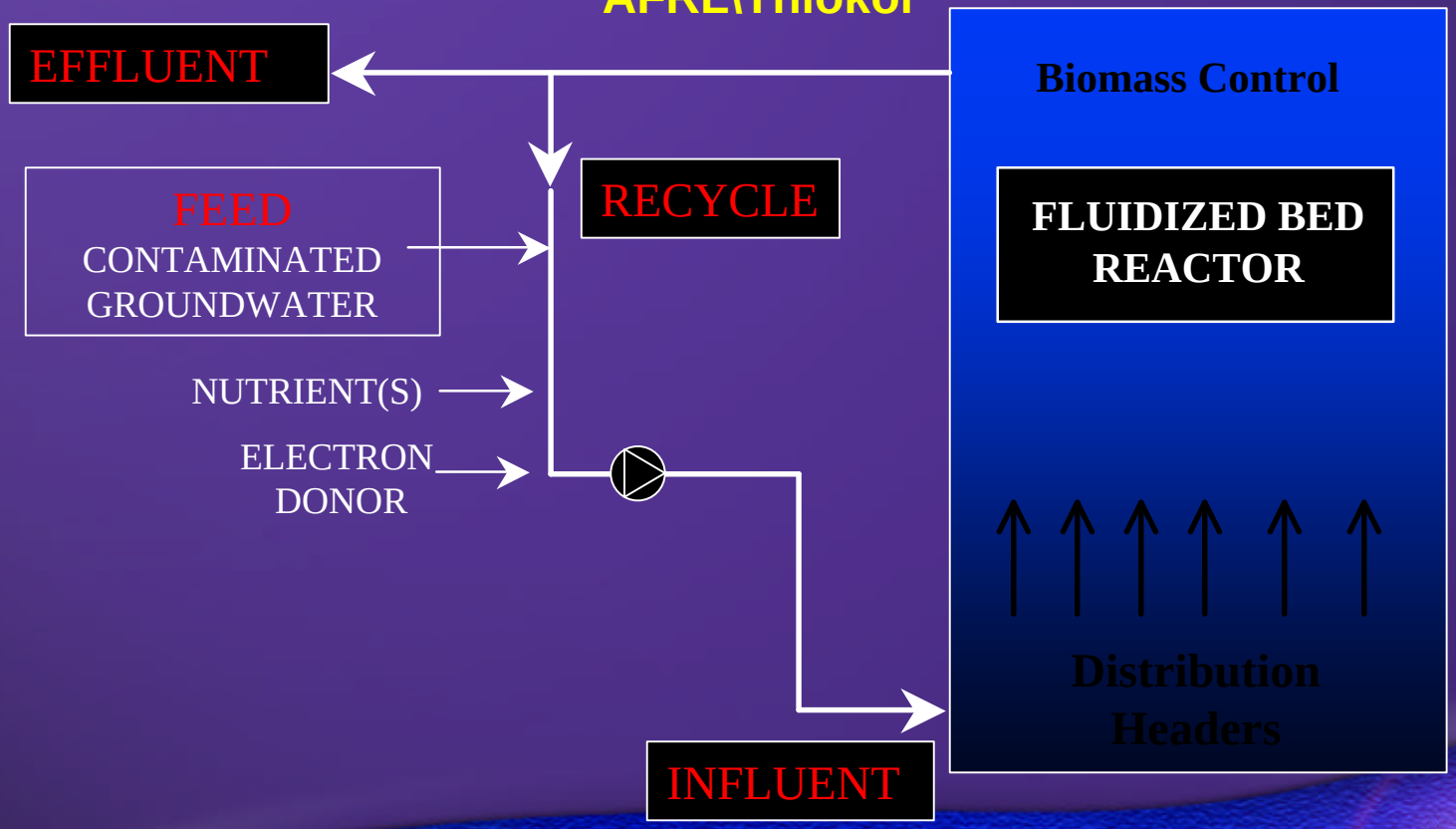
# Selective Ion Exchange Removal of Perchlorate in Groundwater

## Edwards AFB, and ESTCP

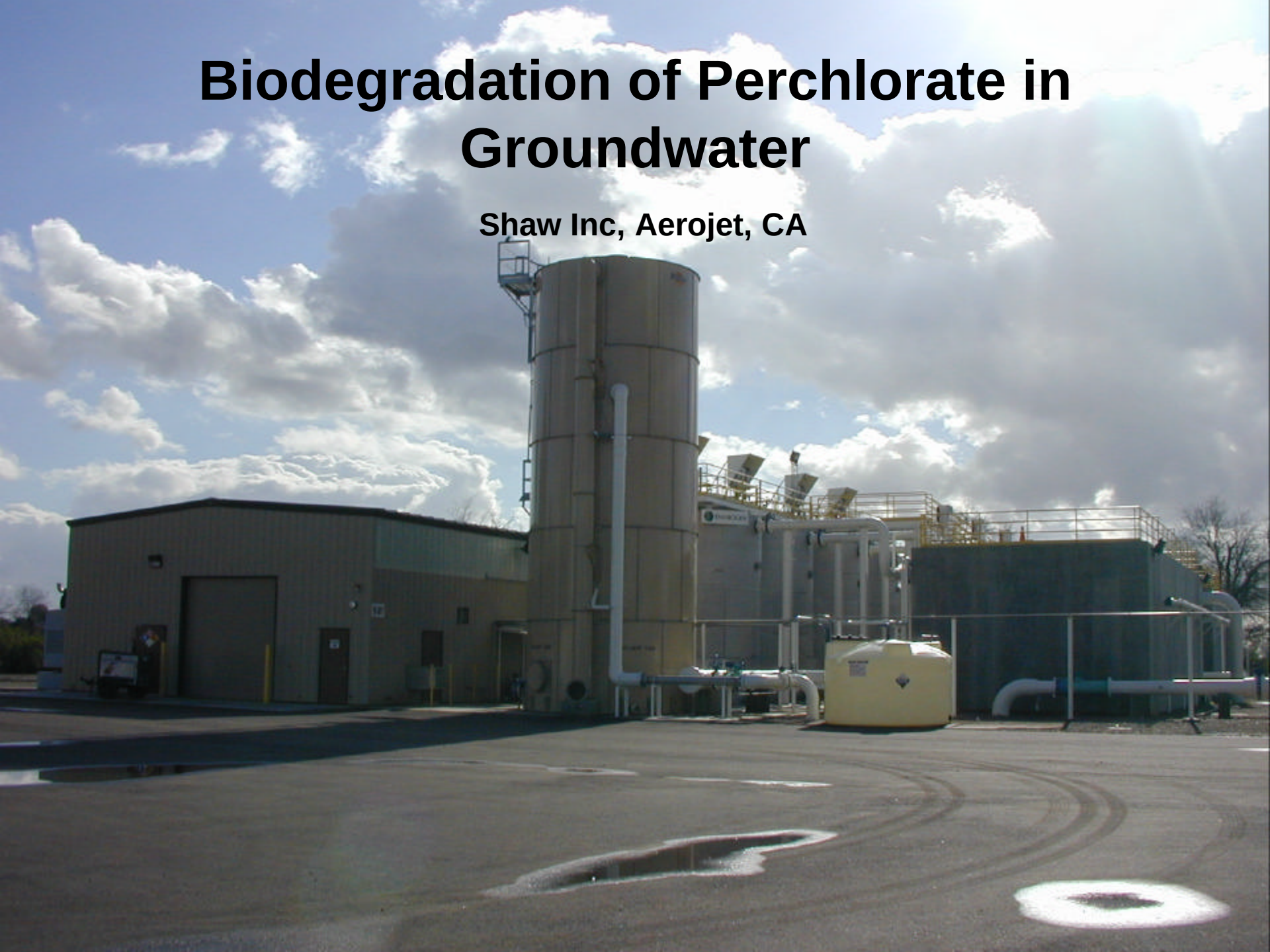
*NAVAL FACILITIES ENGI*

# Biodegradation of Perchlorate in Groundwater

**Shaw (Envirogen Inc,) Longhorn AAP, MMR, NWIRP McGregor AFRL\Thiokol**

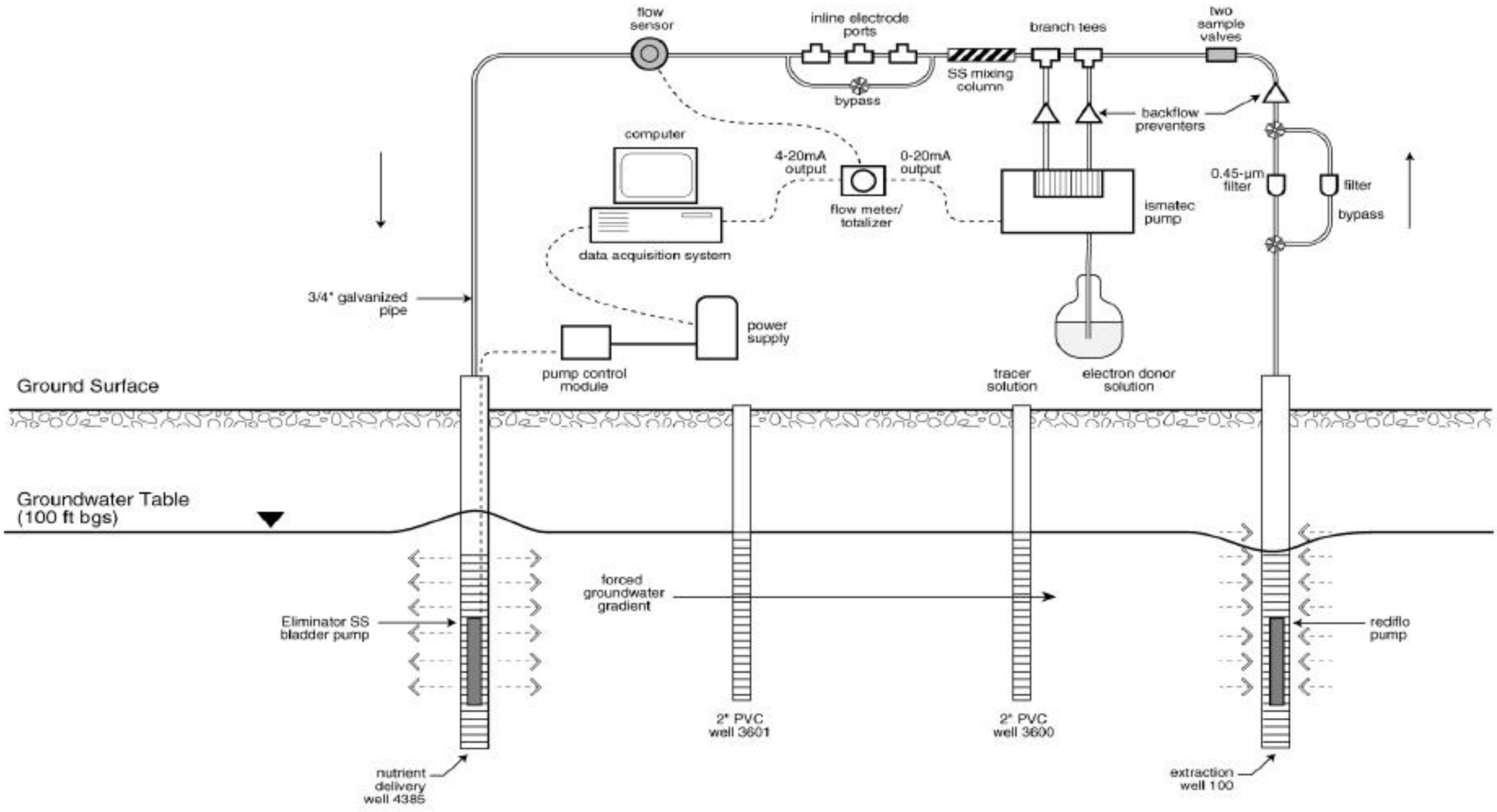


# Biodegradation of Perchlorate in Groundwater



**Shaw Inc, Aerojet, CA**

# In-Situ Bioremediation




**Flow Rate = 5 gpm**

***Cross Section Schematic***
***Area 20 Groundwater Pilot***

# SERDP/ESTCP

**Overview of SERDP bioremediation projects (SIU, Shaw (Envirogen), and Geosyntec)**

- Perchlorate degrading microorganisms are ubiquitous
  - Samples were collected from around the country
- Site Specific Electron Donor
- Microcosms degraded perchlorate < 30 days
- pH lower than 6 may be a problem
- ESTCP projects (Shaw (Envirogen), Geosyntec, and Solutions) just beginning

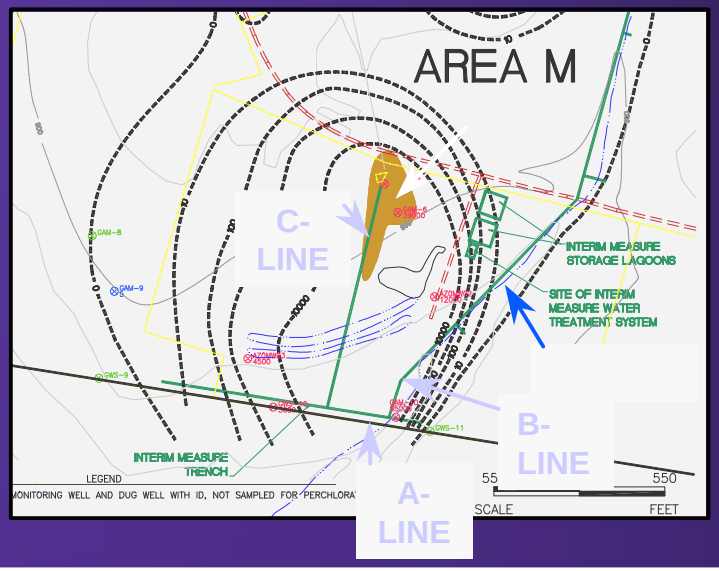
# NSWC Indian Head

- NSWC Indian Head
  - Manufactured Weapon Systems
  - Perchlorate Levels in Groundwater 170 ppm
- Small Pilot System
  - Buffer
  - Electron Donor Addition/Generation
- Catalyst Development
  - Georgetown University
  - Ti (III) to reduce perchlorate

**IHDIV Hogout Facility**

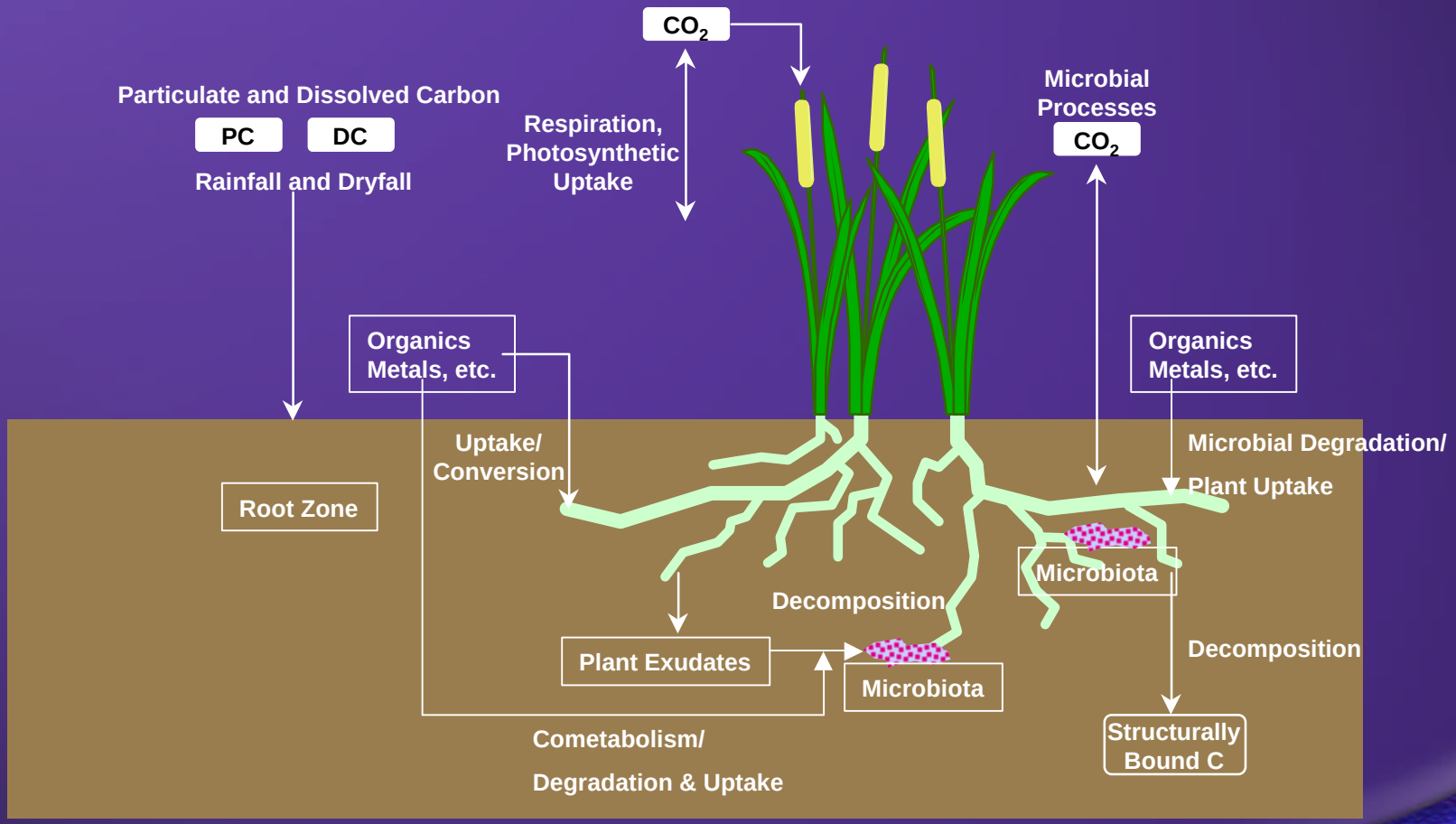
# NWIRP McGregor

- NWIRP McGregor
  - Manufactured Weapon Systems
  - Perchlorate Levels in Groundwater 22ppm, Anaerobic FBR
  - Migration Abatement Letter 2/99
- Treatment System Installed
  - 3 Collection Trenches modified to act as biological reactive barriers
  - Additional Electron Donor added to increase size of reaction zone
- Latest Work
  - Ex-Situ Fluidized Bed Bioreactor
  - Other Areas




# NWIRP McGregor Soil Treatment System

# Phytoremediation



# Summary

DOD Investment in perchlorate treatment technologies to date:

- Over Ten Years of Effort
- Over $25 million dollars
- All Services Have Participated

Wide range of concentrations treated successfully